

Environmental Exposures and Cardiovascular Disease



A Challenge for Health and Development in Low- and Middle-Income Countries

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KEYWORDS

- Environmental health • Air pollution • Household air pollution • Heavy metals • Lead • Arsenic • Cadmium • Cardiovascular disease

KEY POINTS

- Environmental exposures, including air pollution and heavy metal and metalloid contamination, are more prevalent in low- and middle-income countries.
- Exposure to air pollution in the form of ambient air pollution and household air pollution from biomass fuel use is associated with hypertension, acute myocardial infarction, heart failure, arrhythmia, sudden cardiac death, and cardiovascular mortality.
- Lead, arsenic, and cadmium exposures are associated with hypertension, coronary heart disease, and cardiovascular mortality.
- There is increasing epidemiologic evidence of an association of environmental exposures with cardiovascular risk factors and cardiovascular disease, yet most of the research has been conducted in high-income countries.

INTRODUCTION

In the wake of large-scale economic development in low- and middle-income countries (LMIC), environmental pollution has been a challenge that has spurred tension within countries and across regions.¹ The use of fossil fuel combustion to increase access to electricity and transportation for millions of people has simultaneously modernized a multitude of rural and urban communities while locally polluting the air and globally increasing air temperatures.^{2–4} Extractive industries, such as mining, have fueled the economies

of many middle-income countries, lifting large swaths of the population out of poverty while contaminating water with heavy metals.⁵ The conflict over environmental pollution is so intense in some regions that large-scale demonstrations and even violence have erupted, thus threatening national and regional security.⁵ Although many have argued that poverty reduction and economic growth justify the subsequent damage to the environment, the health consequences of environmental pollution, particularly for the populations residing in LMIC, must also be taken into account.^{6,7}

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Exposure to environmental pollution is associated with multiple adverse health outcomes in children and adults. Although environmental pollution often evokes concerns for neurologic development, cancer, and pulmonary disease, cardiovascular disease must be considered as well.⁸ Cardiovascular disease is the top cause of mortality worldwide and has been identified as a target for large-scale, multi-sectoral intervention at the population level.^{9,10} Taking into account the necessary integration of public and private sector activities to reduce the population burden of cardiovascular disease, the substantial impact of environmental exposures on the burden of cardiovascular disease at the population level must be acknowledged and addressed.^{11–13} Understanding the impact of environmental exposures on cardiovascular disease has the potential to yield greater insight into the full human cost of economic development.¹⁴

This review discusses the extent of the exposure, mechanisms of disease pathogenesis, and the impact on cardiovascular disease for the following 5 environmental exposures: air pollution, household air pollution, lead, arsenic, and cadmium (Fig. 1). Although the selected environmental exposures described in this review do not represent an exhaustive list of every exposure with an observed

association with cardiovascular disease, these pollutants represent the most widely studied exposures. While the focus of this review is to discuss the impact of these exposures on cardiovascular disease in LMIC, data from studies of high-income countries are incorporated as needed to better illustrate the full impact of these exposures on cardiovascular disease risk factors and outcomes (Table 1).

AMBIENT AIR POLLUTION

Fossil fuels power economic development in LMIC, fueling the expansion of industry, housing, and transportation. However, fossil fuel combustion releases a heterogeneous mixture of gases and particles, all of which are components of ambient air pollution. Particulate matter is defined as particles suspended in the air of varying chemical composition and can be separated by particle size: coarse particulate matter less than 10 μm in diameter (PM_{10}), fine particulate matter less than 2.5 μm in diameter ($\text{PM}_{2.5}$), and ultrafine particulate matter less than 0.1 μm in diameter ($\text{PM}_{<0.1}$). The gaseous products of fossil fuel combustion include carbon monoxide (CO), nitrogen dioxide, sulfur dioxide, nitrogen oxides, and ozone. PM are heterogeneous in chemical composition and

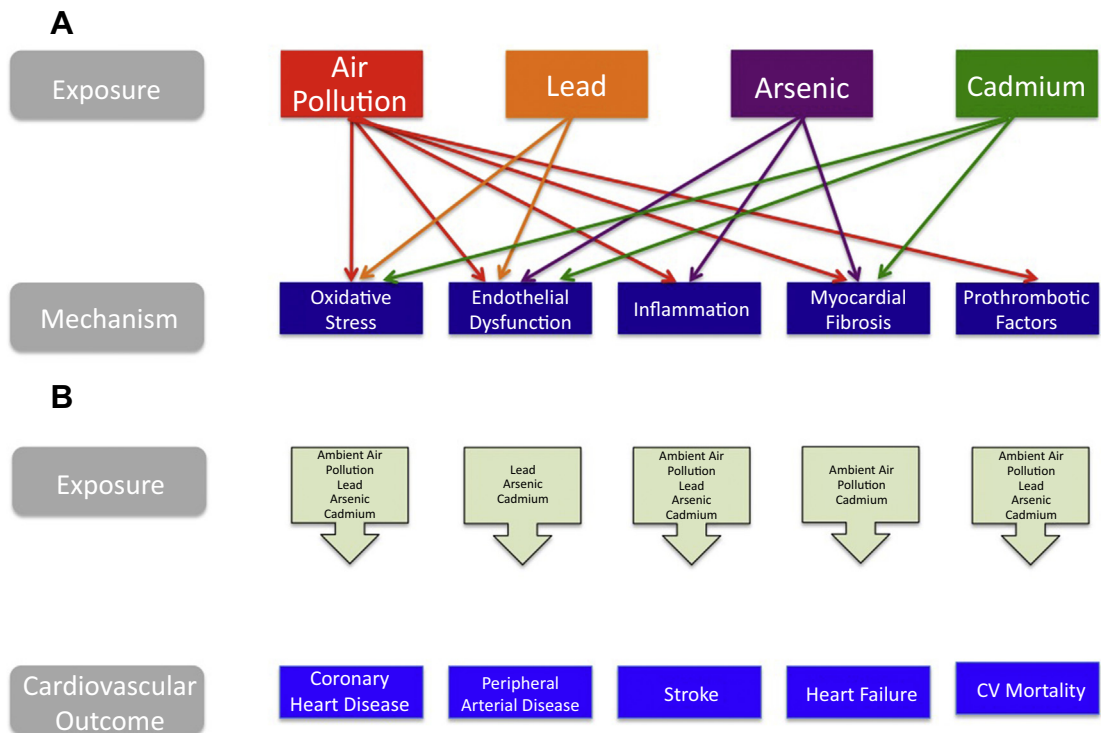


Fig. 1. Summary of the association between environmental exposures, pathophysiologic mechanisms, and cardiovascular disease. (A) Multiple mechanisms by which selected environmental exposures cause cardiovascular injury. (B) Multiple cardiovascular (CV) outcomes that are associated with environmental exposures.

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